

FORMATION OF *PISOLITHUS TINCTORIUS* ECTOMYCORRHIZAE ON CALIFORNIA WHITE FIR IN AN EASTERN SIERRA NEVADA MINE SOIL

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The Gasteromycete *Pisolithus tinctorius* (Pers.) Coker & Couch occurs in temperate, subtropical, and tropical zones worldwide and in ectomycorrhizal association with numerous conifer and hardwood hosts (Marx 1977). Frequent reports of the occurrence of its basidiocarps near various pine species on harsh sites in the eastern United States (Lampky and Peterson 1963, Schramm 1966, Hile and Hennen 1969, Lampky and Lampky 1973, Marx 1975, Medve et al. 1977) have prompted extensive efforts to inoculate seedlings in forest nurseries with this mycobiont (Marx et al. 1976, 1982, 1984, 1989a, 1989b). Subsequently, the improved survival and growth of pine seedlings with *P. tinctorius* ectomycorrhizae after outplanting on surface mines has been attributed to enhanced uptake of nutrients (Marx and Artman 1979) and water (Walker et al. 1989). Current research is focused on development of more effective inocula and inoculation procedures, discovery of locally adapted *P. tinctorius* isolates, and identification of new host species.

A recent report (Walker 1989) disclosed *P. tinctorius* occurring in ectomycorrhizal association with Jeffrey pine (*Pinus jeffreyi* Grev. & Balf.) and Sierra lodgepole pine (*Pinus contorta* var. *murrayana* [Grev. & Balf.] Engelm.) on spoils of the Leviathan Mine in Alpine County, California. Located on the eastern slope of the Sierra Nevada (38°42'30"N, 119°39'15"W) at an elevation of 2,200 m and consisting of approximately 100 ha, this open-pit sulfur mine has been inactive since 1962. The average annual precipitation of approximately 50 cm is primarily snowfall, and the minesoil has a pH of 4.0 to 4.5, a deficiency of plant-available N, and a potentially phytotoxic concentration of Al (Butter-

field and Tueller 1980). Vegetation is sparse on most of the spoils, but in addition to the two pine species mentioned previously, California white fir (*Abies concolor* var. *lowiana* [Gord.] Lemm.), singleleaf pinyon (*Pinus monophylla* Torr. & Frem.), Utah juniper (*Juniperus osteosperma* [Torr.] Little), and quaking aspen (*Populus tremuloides* Michx.) have become reestablished on the periphery of the mine near adjoining undisturbed forest and woodland. Walker's (1989) report concerning examinations made in September 1988 of the probable hosts of *P. tinctorius* in Leviathan Mine noted that basidiocarps of this symbiont were absent in the immediate vicinity of the latter four tree species.

Reexamination of Leviathan Mine spoils in August and September 1989, however, revealed numerous *P. tinctorius* basidiocarps near seedlings and saplings of California white fir. Typically, one or two dark yellow to brown basidiocarps (Fig. 1A), matching the description of Coker and Couch (1928), were observed around solitary white fir seedlings, while as many as five encircled individual white fir saplings. Stipitate, substipitate, and sessile forms were observed, varying in size from 9 to 17 cm in length and from 3 to 7 cm in diameter. Approximately 100 basidiocarps were found associated with white fir, and these were rarely more than 2 m from the host.

Strands of mycelia with gold-yellow pigmentation, which compare favorably with the *P. tinctorius* rhizomorphs described by Schramm (1966), were traced through the spoils from basidiocarps to the root systems of white fir seedlings and saplings. These mycelia were connected to ectomycorrhizae of similar pigmentation that matched the

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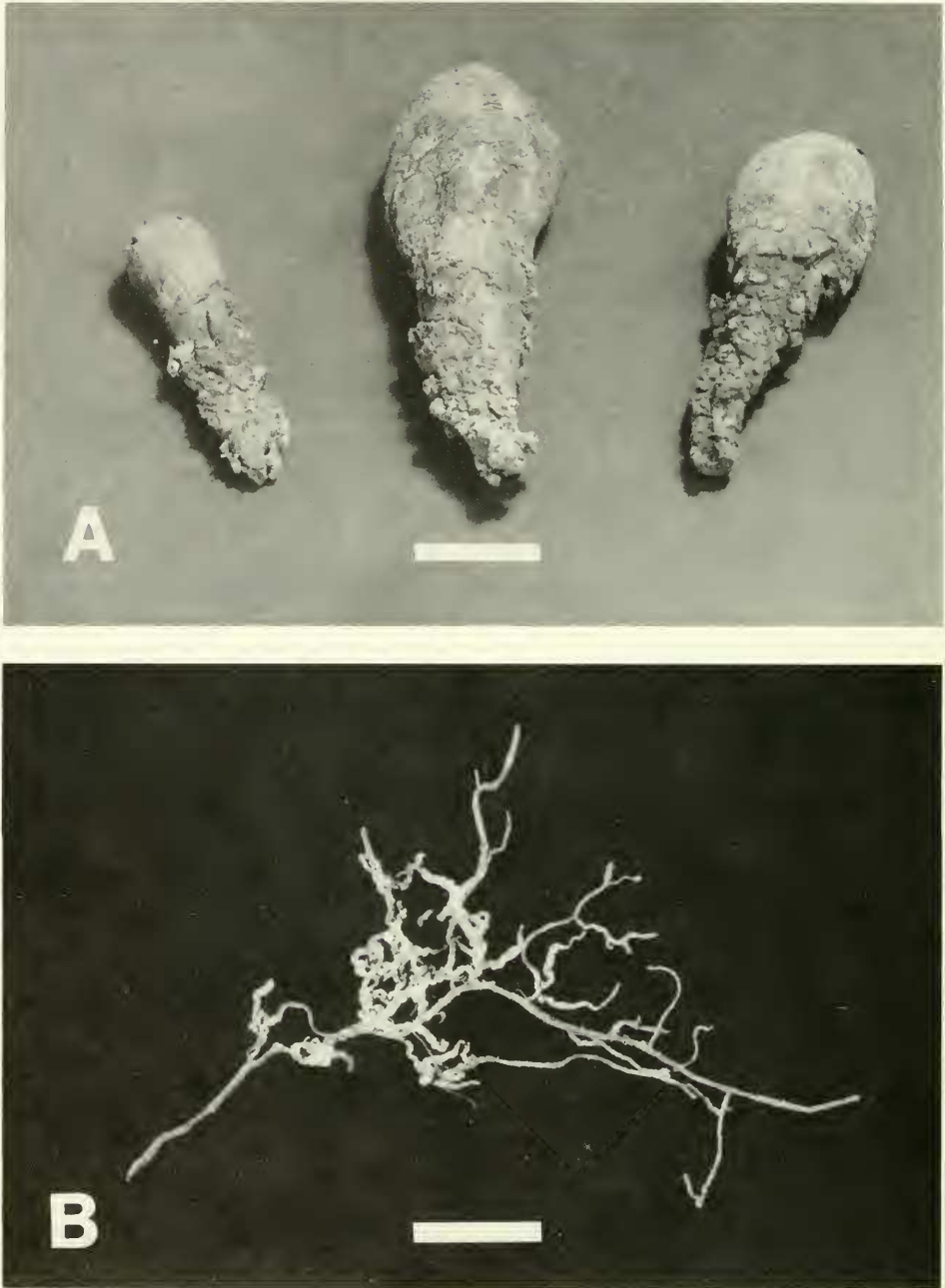


Fig. 1. *Pisolithus tinctorius* associated with California white fir on an eastern Sierra Nevada mine spoil: A, basidiocarps (bar represents 5 cm); B, ectomycorrhizae on roots (bar represents 1 cm).

description of those formed by *P. tinctorius* reported by Marx and Bryan (1975). Examination of the complete root system of an isolated white fir seedling with a single associated basidiocarp revealed numerous *P. tinctorius* ectomycorrhizae with approximately 35% of the roots exhibiting the bifurcate or coralloid form

(Fig. 1B) or the fungal mantle characteristic of these mycorrhizae.

An earlier attempt to inoculate white fir seedlings at outplanting with *P. tinctorius* basidiospores was largely unsuccessful (Alvarez and Trappe 1983). The evidence presented here, however, indicates that this host and

symbiont association occurs naturally in the Sierra Nevada. Efforts to monitor the mycorrhizal development of Sierra Nevada and Intermountain woody flora will continue in order to further ascertain the host ranges of this and other ectomycorrhizal fungi.

ACKNOWLEDGMENTS

This paper contains results of the Nevada Agricultural Experiment Station Research Project 612 funded by the McIntire-Stennis Cooperative Forestry Research Program. The author is indebted to P. M. Murphy of the Division of Forestry, Nevada Department of Conservation and Natural Resources, and to D. C. Prusso of the Department of Biology, University of Nevada, Reno, for their invaluable assistance.

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Received 14 October 1989
Accepted 15 November 1989